

**An Analysis of Alternatives for Alberta Crop Insurance:
A Research Project Submitted to the Alberta Crop Insurance Review Committee**

Allan Mussell, PhD

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Background

As part of its review of the crop insurance program in Alberta operated by the Agriculture Financial Services Corporation (AFSC), the crop insurance review committee is considering alternatives for reforming the current system. One of the crucial issues for reform is the system of establishing and adjusting coverage levels. In a previous research project completed by the George Morris Centre, instances were found in which the risk area average used in setting and adjusting coverage is highly variable, and townships within the risk area were poorly correlated with the risk area average. In risk areas in which both effects occur across multiple crops, coverage adjustments can be erratic and variable.

In response to these observations, the crop insurance review committee is formulating proposals for reform. The purpose of this study is provide an empirical analysis of selected alternatives for reform. These are separated into 3 phases:

- Phase I: Comparison of coverage and premium under a single provincial risk area with the existing coverage adjustment system
- Phase II: Comparison of coverage and premium using surrounding townships as risk areas benchmarks with the existing coverage adjustment system
- Phase III: Initial inquiry into risk areas defined by historical claim rates
- Phase IV: Comparison of coverage and premium under a single provincial risk area with the existing coverage adjustment system using differential adjustment rather than indexing

Phase I Analysis of a Single Provincial Risk Area

The primary motivation for considering alternatives to the current system of coverage adjustments is to increase and improve the stability in coverage levels. The potential advantage of using a provincial average yield benchmark (provincial yield normal), rather than individual risk area normals, is that the provincial normal may be more stable over time. That is, the benchmark used to index individual producers may be more stable. The offsetting factor is that individual yields are likely to be more variable relative to a provincial benchmark than they would from a local benchmark (such as the current risk normal). Both the variability in the benchmark and the variation of individual yields relative to the benchmark affect individual producers' stability in coverage.

Approach

To determine the impact of a single provincial benchmark on coverage and premium cost, the provincial benchmark system was simulated and compared with the current system. Individual coverage data from producers with 8, 9, or 10 years experience in crop insurance with red spring wheat, barley, or canola was used, providing records from of 7085 producers. The distribution of these records across risk areas for the 3 crops is presented in Figure 1. Under the two coverage adjustment systems,

producers were initially underwritten based on the current startup coverage system which uses surrounding townships to establish the benchmark coverage. The level of coverage was established using the current system. Yield normals were calculated as the exponential moving average of benchmark yields since 1974. Coverage was simulated for each individual and each crop over a 10 year period. The results were calculated at the producer level over the 10 year time period (weighted by acreage in each year), and then averaged across producers based on mean acreage. Comparisons were made between the two programs at the 70% level of coverage based on measures of coverage level, variability in coverage, and implied premium cost.

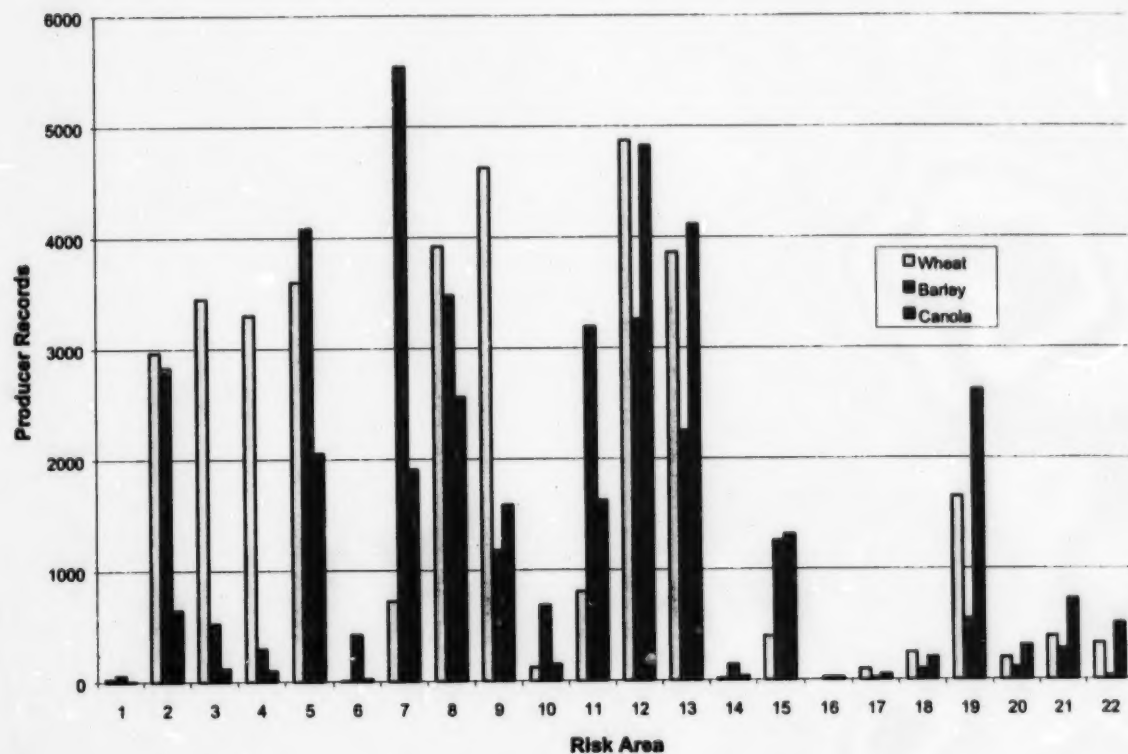
The data were initially tested for structural change during the sample period to determine if the changing geographic distribution of crops over time caused bias in the data. This "geographic drift" of crops into areas that previously had been less suitable growing areas influences the statistical distribution of crop yields at the provincial level; this is much less pronounced within individual risk areas under the current system. To account for geographic drift, the acreage distribution of the 3 crops was fixed according to an index time period, so observed yields are attributed to the index acreage. The provincial yield normal was calculated using the weighted average of risk area normals, with the risk areas' acreage shares in the index period used as weights. This removes geographic drift as an additional source of variability in producer and risk area yields. Index periods of 1979-80 and 1997-99 were tested in the provincial risk area. Results run under the two index time periods showed that geographic drift did not significantly affect the results, so the 1997-99 index period was retained.

The key criteria for evaluation of the two systems is the mean level of coverage, the variability in coverage, and the cost of the program. One of the primary concerns is that coverage levels are too low under the current system; comparison of mean coverage levels provides an immediate interpretation as to which system provides more coverage. The standard deviation in coverage measures the stability in farmer's yield insurance from year to year. In the previous study, a number of risk areas were found in which coverage adjustments were volatile (high standard deviation); lower standard deviation means less volatility in coverage. The coefficient of variation places the standard deviation in context so that it can be compared across regions and crops. The mean percentage variation from year to year gives the average change in coverage from one crop year to the next. Finally, the cost of the program is measured by the claim rate. Because the insurance is offered on a fair basis, the premium cost is set based on the expected indemnities that will be paid. The claim rate gives the historical ratio of indemnity payments to risks covered, so it reflects both the frequency and magnitude claims. The percentage change in the claim rate that would occur due to a change in crop insurance programs approximates the percentage change in the cost of the program.

Results

The results are presented in Tables 1.1, 1.2, and 1.3 below. The first row of the tables gives the

Figure 1.1 Distribution of Wheat, Barley, and Canola Yield Records by Risk Area



mean producer yield coverage (at 70% coverage) across all producers under the two scenarios. For all 3 crops, the tables show that yield coverage increases slightly moving to the single provincial risk area. In red spring wheat, the average yield coverage increases 2.7%, in barley 4.2 %, and in canola 5.4%. Appendix tables 1.1, 1.2, and 1.3 show that while the coverage increases on average, the implications for coverage in the individual risk areas is somewhat varied. This mean increase in coverage levels occurs because a greater degree of cushioning occurs at the provincial level than at the risk area level. In other words, increasing the size of the pool of risks increases the degree of cushioning, so on average, coverage levels increase.

At the same time, the variability in coverage increases moving to the single provincial risk area. This is evident from the standard deviation on coverage presented in the second row of the tables, the coefficient of variation in the third row, and the percentage year to year variation in the fourth row. The standard deviation increases from average of around 11% for canola up to 15% for red spring wheat moving to the single provincial risk area. The coefficient of variation, which normalizes the standard deviation is greater under the single provincial risk area for wheat and barley and approximately equal for canola. The average percentage change in coverage from year to year is also higher under the single provincial risk area for all 3 crops.

Moving to the single provincial risk area, the claim rate increases by just under 16% for red spring wheat up to almost 18% for barley and canola. This occurs because the additional variance under the single provincial risk area increases the incidence of cushioning, which increases the level of coverage, which in turn increases the cost of the program. In effect, the slight increase in coverage is accompanied by a disproportionate increase in program costs.

The Structure of Variation in Coverage

The variation in coverage can be decomposed into two sources. There is variation in coverage that results from variation in the yield benchmark (risk area normal) and from individual yield variation around the benchmark (variance in index). The lower the variance in individual yields around the benchmark and the variance in the benchmark itself, the lower the variance in individual coverage. Moving to the provincial risk area from the current risk areas, the variance in the benchmark is expected to decrease because there are a greater number of records spread over a wider area, so high yields in one region tend to wash out the impact of lower yields in another. Conversely, moving to the provincial benchmark is expected to increase the variance of individual yields against the yield benchmark, and hence the variance in coverage index. This is because individual yields are being compared against a benchmark that contains data from other regions with different agronomic conditions. Moving from the current risk areas to the provincial risk area, the question is which effect dominates.

The summarized results are presented in Table 1.4 below. The table shows that individual coverage is more variable under the provincial risk area than under the current system; this means that the increase

in variance between individual yields and the benchmark (indexing) dominates the decrease in the variance in the benchmark. For all 3 crops, the normal is more variable under the current risk area scheme than under a provincial benchmark (as expected).

Table 1.1 Summary of Red Spring Wheat Results

	Single Provincial Risk Area Scheme	Current Risk Area Scheme	% Change from Current RA Scheme
Mean 70% Coverage (kg/acre)	600	584	2.57
Std Deviation in 70% Coverage (kg/acre)	60	51	2.67
Coefficient of Variation in 70% Coverage	0.1	0.087	14.9
Mean % Year to Year Variation in Coverage	6.1	5.3	15.1
Mean % Change in Yield Normal	0.9	1.1	-18.2
Mean Claim Rate	2.3	2.1	+ 9.5

Table 1.2 Summary of Barley Results

	Single Provincial Risk Area Scheme	Current Risk Area Scheme	% Change from Current RA Scheme
Mean 70% Coverage (kg/acre)	875	840	4.2
Std Deviation in 70% Coverage (kg/acre)	78	68	-0.5
Coefficient of Variation in 70% Coverage	0.089	0.081	-8.6
Mean % Year to Year Variation in Coverage	5.1	4.7	+ 8.5
Mean % Change in Yield Normal	0.9	1.2	-25
Mean Claim Rate	2.7	2.4	+12.5

Table 1.3 Summary of Canola Results

	Single Provincial Risk Area Scheme	Current Risk Area Scheme	% Change from Current RA Scheme
Mean 70% Coverage (kg/acre)	368	349	+ 5.4
Std Deviation in 70% Coverage (kg/acre)	41	37	+ 10.8
Coefficient of Variation in 70% Coverage	0.11	0.11	-
Mean % Year to Year Variation in Coverage	5.7	5.3	+ 7.55
Mean % Change in Yield Normal	0.9	1.3	-30.8
Mean Claim Rate	3.5	3.1	+ 17.7

Table 1.4 Decomposition of Variance in Individual Coverage

	Red Spring Wheat		Barley		Canola	
	Provincial	Current	Provincial	Current	Provinci al	Current
Std. Deviation in Normal (kg/acre)	21	22	30	36	11	15
Std. Deviation in Index	0.09	0.09	0.09	0.08	0.11	0.11
Std. Deviation in 70% Coverage (kg/acre)	60	51	78	68	41	37

Because the variability in coverage is greater under the single provincial risk area, it must be that the variability in index is greater under the single provincial risk area. This is clear for barley; the results for red spring wheat and canola show that the standard deviation in indexes are approximately equal. The wheat and canola results are due to rounding; in fact, for all 3 crops the variability in coverage index is greater under the single provincial risk area, and this effect dominates the reduced variability in the normal so the single provincial risk area gives greater variability in coverage.

Conclusions

The results of the analysis show the following:

- Under the single provincial risk area, coverage levels would increase slightly (by 5% or less)
- Under the single provincial risk area, the standard deviation in coverage would increase (by between 11 and 18%)
- Due to the increase in coverage and the increase in coverage standard deviation, the single provincial risk area scheme would increase program expenses by 16-18%

While the single provincial risk area would increase coverage levels slightly, it would do so with greater variability in coverage and at increased costs. Thus, it provides only limited potential for improvement over the current system.

Extensions

This analysis was undertaken at the 70% level of coverage. It is useful to consider how the results would change if the analysis had been done at 80% coverage. Many of the results would change in a very predictable way, because the yield normal and indexing would remain the same. The mean and standard deviation in coverage would increase by a factor of approximately 80/70 (14%). However, the claim rate would increase by a greater amount (perhaps much greater). This is because the probability of a claim is much greater at the 80% level of coverage than at 70%. To illustrate, moving from 70% coverage to 80% coverage, everyone that claimed at 70% also claim at 80%. However, the claims are larger in magnitude than they were at 70%. In addition, there are producers who claim at 80% that would not have claimed at 70%. Thus, moving from 70% to 80% coverage increases the number and the magnitude of claims, so the premium cost increases significantly.

Phase II Analysis of the Surrounding Township Averages to Establish Virtual Risk Areas

Background

Variance in coverage derives from variance in the coverage benchmark (normal) and from variance in individual yields relative to the risk area average. In designing a geographic system of risk areas these sources of variation must be traded off. In the previous section, we observed that moving from the current system of risk areas to a single provincial risk area decreased the variation in the coverage benchmark. However, the increase in variation of individual yields relative to the provincial risk area average more than compensated, and total variation in coverage increased under the single provincial risk area. Thus, it may be that moving to smaller geographic areas, with expected higher benchmark variation in yields but lower variance in individual yields relative to the benchmark average can reduce total variation in coverage.

Virtual Risk Areas

An existing system with smaller benchmark areas than the current system was used to test this hypothesis. The startup coverage system used for new entrants to crop insurance sets coverage at the risk area normal multiplied by the ratio of the average yield in the producer's township and the surrounding 8 townships to the risk area average. This system is seamless; it has no fixed geographic boundaries, and the data used to compute the yield average used in indexing each township is unique. For this reason, the risk areas could be termed "virtual". This system is used until the producer has 3 years of individual yield records; individual yields are used after 3 years. From the analysis in an earlier study, this system is a good predictor of eventual yields and coverage.

In this analysis, we consider a system of coverage adjustment similar to the startup coverage adjustment system. The normal is computed from the surrounding 9 townships using the existing smoothing formula. Individual coverage is set by adjusting this normal by the ratio of the cumulative individual yield to the 9 township cumulative average yield, and cushioning occurs relative to the 9 township cumulative average.

Approach

(i) Exclusionary Criteria

To study the impact of virtual risk areas, the following procedures were employed. Data were collected from farmers with 8, 9, or 10 years experience in RS wheat, barley and canola. Individual yields were summarized by crop and township for red spring wheat, barley, and canola. For each township, the average yield for all fields included in the township or one of the eight surrounding townships was calculated to give the 9 township average yield. Those average yields calculated using

data from less than 30 fields were considered unreliable and were discarded. To ensure consistency, only yields from townships with a complete yield history for 1974-1997 were included. Townships that could not be uniquely assigned to a risk area (because the risk area boundary runs through a township) were discarded to assure that individual yield data was assigned to the same risk area consistently.

(ii) Data Procedures

Yield normals were calculated for each township using the exponential smoothing procedure employed under the current system and restated to reflect 70% coverage. Farmers' coverage was initially set using the startup procedure employed under the current system. Individual coverage adjustments were calculated using the current methodology including cushioning, replacing risk area averages with township averages and using the same individual yield data for both the virtual risk area and current system scenarios. Farmers were sorted into dominant townships for each crop based on their historical acreage in that crop. Individual coverage for each crop and year was restated to 70% using the restated township normal for the dominant township (same for all years) and the individual coverage adjustment. The data were restated where all of the acreage, individual yield, township average yield and township normal were available. The resulting data were compared under the virtual risk area and current system scenarios.

Results

The results were analyzed using average coverage levels and variance in coverage as criteria. Moving from the current risk areas to virtual risk areas, somewhat lower average coverage levels were expected, because there will tend to be less cushioning. The impact upon coverage variance is an empirical question that resisted speculation prior to testing.

The exclusionary criteria resulted in a smaller database of producer records than in the analysis of the single provincial risk area. Figure 2.1 presents the distribution of farmer records used in the analysis. The exclusionary criteria resulted in fewer records from the Peace River and northern regions of the province relative to the single provincial risk area analysis.

The results of the analysis are presented in Tables 2.1, 2.2, and 2.3; individual risk area results are presented in Appendix tables 2.1, 2.2, and 2.3. The results show some of the anticipated impacts of the 9-township virtual risk area. For barley and canola, there is a trivial decrease in the average level of coverage that stems from less cushioning. The variability in coverage decreases under the virtual risk areas relative to the current system for wheat and barley. The standard deviation in RS wheat coverage decreases by 9.5%, and by 1.5% in barley. The coefficient of variation for RS wheat decreases by 8.4%, and by 1.4% for barley. The standard deviation and coefficient of variation in coverage for canola remains unchanged. For each crop, the yield normal under the virtual risk area is significantly more variable than under the current risk areas. The claim rate data in the tables show that insuring the virtual risk areas appears to be somewhat less costly than the current system. The claim rate decreases

under the virtual risk areas by 4.3% for RS wheat, 3.3% for barley, and 2.6% for canola.

To better understand the nature of the variance in coverage, the variance is decomposed into the standard deviation in the yield normal and the standard deviation in index. The results are presented in Table 2.4. As expected, the yield normals are more variable under the virtual risk

Figure 2.1 Sources of Data by Crop and Risk Area

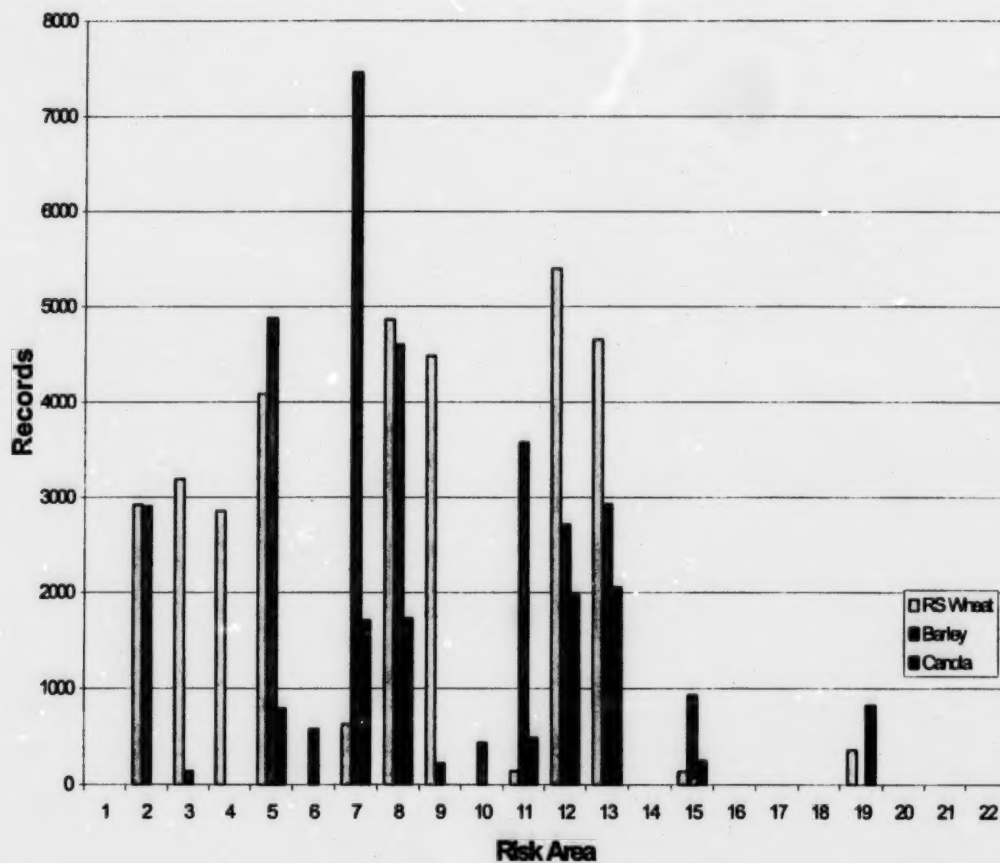


Table 2.1 Summary of Red Spring Wheat Results

	9 Twp Virtual Risk Area Scheme	Current Risk Area Scheme	% Change from Current RA Scheme
Mean 70% Coverage (kg/acre)	588	588	-
Std Deviation in 70% Coverage (kg/acre)	38	42	-9.5
Coefficient of Variation in 70% Coverage	0.065	0.071	-8.4
Mean % Year to Year Variation in Coverage	4	4.4	-9.1
Mean % Change in Yield Normal	1.4	1	+ 40
Mean Claim Rate %	2.2	2.3	-4.3

Table 2.2 Summary of Barley Results

	9 Twp Virtual Risk Area Scheme	Current Risk Area Scheme	% Change from Current RA Scheme
Mean 70% Coverage (kg/acre)	886	888	-0.2
Std Deviation in 70% Coverage (kg/acre)	64	65	-1.5
Coefficient of Variation in 70% Coverage	0.072	0.073	-1.4
Mean % Year to Year Variation in Coverage	3.9	4.1	-4.9
Mean % Change in Yield Normal	1.3	1.1	18.2
Mean Claim Rate %	2.9	3	-3.3

Table 2.3 Summary of Canola Results

	9 Twp Virtual Risk Area Scheme	Current Risk Area Scheme	% Change from Current RA Scheme
Mean 70% Coverage (kg/acre)	377	378	-0.3
Std Deviation in 70% Coverage (kg/acre)	31	31	-
Coefficient of Variation in 70% Coverage	0.082	0.082	-
Mean % Year to Year Variation in Coverage	4.5	4.5	-
Mean % Change in Yield Normal	1.5	0.8	87.5
Mean Claim Rate %	3.7	3.8	-2.6

Table 2.4 Decomposition of Variance in Coverage

	Red Spring Wheat		Barley		Canola	
	9 Twp Avg	Current	9 Twp Avg	Current	9 Twp Avg	Current
Std. Deviation in Normal (kg/acre)	20	16	34	30	13	8
Std. Deviation in Index	0.061	0.07	0.067	0.072	0.079	0.084
Std. Deviation in 70% Coverage (kg/acre)	38	42	64	65	31	31

areas than the current risk areas. However, the virtual risk areas have a lower standard deviation in index. The net effect is that the reduction in coverage variability due to indexing exceeds the increase in variability due to the normal, so that coverage is more stable under the virtual risk areas.

Conclusions

The results suggest that the 9-township virtual risk areas could offer improvements in the crop insurance system. The virtual risk areas give similar levels of coverage to the current system with reduced variance in coverage and lower cost. Applying the criteria that crop insurance should provide high levels of coverage and low levels of variability in coverage, this is an unambiguous improvement. In addition, by design, virtual risk areas avoid the boundary issues that occur under a system of set geographic risk areas. Coverage levels tend to move in a gradient across regions, rather than a set boundary defining (potentially) sharp differences in coverage.

A caveat in interpreting these results is that because of the additional exclusionary conditions applied, the sample of producers in the virtual risk area analysis has fewer records and less area representation than the current system. The exclusionary criteria leaves about 60% of the initial population in the sample, and it particularly omits northern regions of the province that do not have as long a yield history. However, the sheer number of records suggests that the virtual risk area analysis should be representative, so it is reasonably comparable with the other coverage scenarios simulated. If the analysis is indeed representative of the province, and it impacts other crops the same way it does red spring wheat, barley, and canola, the virtual risk areas offer promise in improving crop insurance coverage.

Phase III Analysis of the Claim Rate in Defining Risk Area Boundaries

Background

Crop insurance programs in Alberta and elsewhere in North America operate on a breakeven basis. That is, the coverage and premium are set such that, over time, the money paid into the program is just equal to the expected amount of money paid out in indemnities. Within the system, in a given year a particular region can draw out more than it has paid in while other regions pay in more than they draw out in indemnities. If this occurs randomly over time, the system is effectively pooling risk. Alternatively, specific regions may persistently draw out more in indemnities than they contribute in premiums. When this occurs, systematic cross-subsidization is occurring and group coverage and/or premiums are adversely affected by the region that persistently draws out of the pool.

Risk areas designed around regions with similar soil type or precipitation levels attempt to remove systematic cross-subsidization so that risk pooling due only to random effects remains. However, the agronomic factors are really only a proxy for actual claims in the region relative to the risk that was covered. The actual frequency and magnitude of claims is measured by the *claim rate*. The claim rate in an area is the percentage of total risk paid out in indemnities, or

$$\text{Claim Rate} = \text{Total indemnities paid (\$/ Total Risk(\$)}$$

where total risk is the acreage* coverage*price election level

Historic claim rates summarize the information on yield risk in an area, including agronomic factors and any systematic factors that influence farmer behaviour. The higher the historical claim rate for an area, the riskier the region is, so there is a greater probability that future claims will occur.

For an established system of zones (e.g townships or counties), the historic claim rate can be calculated. This provides a means to sort more risky zones from less risky zones and establish risk areas based on zones with similar risk profiles. The claim rate thus has attraction as a means of establishing new risk areas.

Empirical Analysis

To investigate risk areas based on the claim rate, historical data from the population of individual producers were assembled for the period 1978-1997. Based on historical yields, individual startup coverage and subsequent coverage adjustments were simulated under the current system and under a single provincial risk area. Individual claim rates were calculated based on the simulated yields and

coverage, with the individual claim rates restated back to the township level based on producers' relative acreage across townships.

A number of scenarios were run. First, for each crop, the individual producer claim rates were calculated based on the current risk area normals and indexing. These were attributed back to the township level based on producers' historic acreage distribution across townships. From the producer records, township average claim rates were calculated and averaged across the surrounding 9 townships. These "raw" claim rates were indexed by the provincial average claim rate to give relative claim rates for red spring wheat, barley and canola, and for the 3 crops combined. This approach facilitates easier comparison across crops.

A parallel set of scenarios were run using the provincial normal as a benchmark. To keep the empirical analysis tractable, no indexing of individual yields to the provincial benchmark was simulated; individual coverage was set at the provincial normal. This does not effect the interpretation of claim rates or relative claim rates within the provincial normal scenarios.

The results of these analyses are presented in the accompanying maps. In examining the maps of claim rates under the current coverage adjustment system, look for townships that can be grouped by claim rate classification and how they relate to the current risk area boundaries. The 9-township averaging system greatly facilitates these groupings. The accompanying claim rates for individual townships show the number of townships (and actual claim rates) that the 9 township average is based upon, which reveals how representative the 9 township average is. The concept behind risk areas is that regions of similar risk profiles are grouped together. The maps illustrate how well the current risk areas account for risk across regions, and suggest township groupings that could form new risk areas.

Claim Rates Using the Current System Benchmarks

Consider Map 1, the map of the claim rates for the 3 crops combined using the 9 township averages. In particular, notice the highest claim rate regions (in red and pink). There is a visible collection of high risk townships in the following areas:

- Risk Area 2
- Northern Risk Area 4
- Risk Area 9
- Risk Area 10
- Risk Area 13
- Eastern Risk Area 15
- Southeastern Risk Area 17
- Northern Risk Area 18
- Risk Area 19
- Southwestern Risk Area 20
- Risk Area 21

The map also suggests some expedient ways in which the higher claim rate townships could be grouped:

- Risk Area 4 could be divided into the high (red) claim rate portion in the north and the remainder
- The northern portion of Risk Area 18 could be shifted into Risk Area 21
- The southwestern portion of Risk Area 20 could be incorporated into Risk Area 17

Map 2 gives the claim rates for the 3 crops combined on a relative basis. The townships coloured in red, pink or grey have claim rates greater than the provincial average; the light and dark blue townships have below average claim rates. The map reflects the same trends evident from the raw claim rates in Map 1. Portions of Risk Areas 21, 18, 17, 20, 10, 15, 13, 9 and 4 show up as containing clusters of townships with relatively high claim rates.

Maps 3, 4, and 5 illustrate the relative claim rates for red spring wheat, barley, and canola, respectively. Wheat Map 3 shows relatively high claim rate areas within current Risk Areas 4, 15, 17, 18, 19, 20, and 21. Red spring wheat explains virtually all of the high claim rates in northern Risk Area 4. Map 4 gives the relative claim rates for barley. Pockets of relatively high barley claim rates exist in western Risk Area 9, Risk Area 13, Risk Area 19, and Risk Area 21. Map 5 presents the canola claim rate results. The only areas with noticeably high relative claim rates for canola are in the Peace River region, especially Risk Areas 18, 19, and 21. Risk Areas 9, 13 and 15 are notable for their variation in relative claim rates, containing townships with very low and very high claim rates.

The claim rates by crop provide intuition as to the distributional impacts of the combined claim rates. In other words, if the risk areas that are identified above as having relatively high claim rates were treated as such, how would it impact each of the 3 crops? The analysis of the 3 crops combined suggested that Risk Areas 2, 4, 9, 10, 13, 15, 17, 18, 20, and 21 had relatively high claim rates in whole or in part. An informal analysis that looks at the relative frequency of high claim rate townships on the 9 township average map (i.e. pink or red), and considers the number of townships from which the average was calculated provides the following insights:

- Risk Area 2 has only a marginally high claim rate based on wheat and barley, but not based on canola
- Risk Area 4 has a high claim rate based on wheat, and has literally no barley or canola. It has a relatively small number of townships from which data was obtained
- In Risk Area 9, the relatively high claim rate is supported by barley. The claim rate for wheat is highly variable, and there is no canola to speak of.
- Risk Area 10's high claim rate is based on barley results for a small number of townships
- Risk Area 13 has relatively high claim rates for all 3 crops, with a large number of townships reporting

- Risk Area 15 has marginally high claim rates for all 3 crops, with great variability across the risk area
- In Risk Area 17, claim rates are supported by a high canola claim rate reported over relatively few townships.
- Risk Area 18 has high claim rates across all 3 crops
- Risk Area 19 has high claim rates across all 3 crops
- The claim rate in Risk Area 20 is based on barley and canola results
- Risk Area 21 has high claim rates across all 3 crops.

Claim Rates Using the Provincial Normal Benchmark

The raw claim rates for the 3 crops combined based on a provincial normal are presented in Map 6. The 9-township average claim rates show pronounced patterns of high claim rate township in red and pink. The following risk areas show concentrated regions of higher claim rates: 2, 3, 4, 9, 10, 13, 15, 17, 18, 19, 20, 21, and 22. The greater frequency of high-claim rate townships is due to claim rate classes retained from the analysis under the current system, and the fact that the yields are not indexed. However, the raw claim rates highlight many of the same higher risk regions found under the current system. In particular, Risk Areas 4, 9, 18, 19, and 21 show up with noticeably high claim rates. The relative claim rates for the 3 crops combined in Map 7 correct for the lack of indexing in Map 6. It shows that the risk areas with relatively high claim rates are 4, 9, 13, 15, 17, 18, 19, 20, 21, and 22. Risk Areas 13 and 15 in particular have clusters of townships with high relative claim rates and others with low relative claim rates.

The impact of the combined claim rates by crop based on the provincial normal (presented in Maps 8, 9, and 10 for red spring wheat, barley, and canola, respectively) is as follows:

- The high claim rates in Risk Area 2 are due to barley
- Risk Area 4 has a relatively high claim rates due to red spring wheat yields
- Risk Area 9 has relatively high claim rates across all 3 crops
- High relative claim rates in Risk Area 10 are due to barley, but there is significant variation in claim rates (some are low)
- Risk Area 13 has relatively high barley claim rates, with variable claim rates for canola
- Risk Area 15 has relatively high claim rates for barley and canola, but there is variation in both barley and canola results and few townships reporting data
- Risk Area 17 shows relatively high claim rates in red spring wheat and canola, but has few townships reporting
- The relatively high claim rates in Risk Area 18 occur across all 3 crops, with few townships reporting data
- Risk Area 19 show high relative claim rates for barley and variable claim rates for canola
- Risk Area 20 has relatively high claim rates for barley and canola, but only a small number of townships reporting

- Risk Area 21 has relatively high claim rates across the 3 crops, but few township observations for red spring wheat
- Risk Area shows some relatively high claim rates for canola, but with significant variation within the risk area.

Observations and Conclusions

The purpose of this analysis was to explore the use of the claim rate as an approach to establishing risk area boundaries. It provides an alternative means to classify areas by risk and set premium and coverage policies. One way to interpret the combined 3 crop analysis using the current risk area normals is that it directs how current risk area boundaries could be redrawn to better group townships with similar risk characteristics. On this basis, some preliminary suggestions for fine-tuning emerge:

- combine northern Risk Area 4 with Risk Area 9 and move the remainder of Risk Area 4 in with Risk Area 3
- there may be some advantages from combining the central portions of Risk Areas 13 and 15, since the western and eastern sections of both risk areas generally have lower claim rates. Perhaps eastern Risk Area 13 and 15 could be merged into 12, and the western sections merged into 11
- northern Risk Area 18 and Risk Area 19 could be merged into Risk Area 21, with the southern portions of Risk Areas 18 and 19 combined

These results seem to confirm the findings in the initial study presented to the review committee that suggested problems with coverage and adjustments in Risk Areas 4, 9, and 13.

An interpretation of the results based on the provincial normals is that, if we were to redesign risk areas from a blank map, the relative claim rates based on a provincial normal could be used to establish boundaries. For practical purposes, it seems to make the most sense to consider risk areas for all crops rather than different risk areas for different crops. As a result, the analyses with the 3 crops combined are the most relevant. Some preliminary observations of similar claim rates suggest the following:

- Combine Risk Areas 1, 2, 3, and southern 4
- Combine Risk Areas 5, 6, 7, and 8
- Combine Risk Area 9 with northern Risk Area 4
- Partition Risk Areas 13 and 15 into eastern and western sections
- Create a southern Peace River risk area and a northern Peace River risk area

The observations from the current system and provincial normal have similar implications. They should be treated as preliminary, however. The reason is that establishment of new risk areas based on these claim rate clusters will generate their own new system of normals. The claim rates based on the new set of normals would need to be estimated before the impact of adjustments to current risk areas or an entirely new set of risk areas could be determined.

In most cases, the claim rate patterns do not precisely follow risk area boundaries. This suggests that claim rates could be a useful tool for crop insurance reform.

Phase IV Analysis of a Single Provincial Risk Area With Absolute Adjustments

Background

In Phase I of the project, the impact of a single provincial risk area was analyzed. The results showed that the single provincial risk area gave slight increases in coverage, but at a significant increase in coverage variability and cost. However, this conclusion was obtained assuming the same system of coverage adjustment that is currently in place, in which a producer's coverage is indexed based on the ratio of his cumulative average yield relative to the cumulative risk area average. An alternative approach upon which to base coverage adjustments is adjust coverage based on the *absolute difference* between a producer's cumulative average yield and the cumulative risk area average. This option is analyzed here.

Approach

Under the current "ratio" approach to indexing, a producer's coverage in a given year t (ignoring cushioning) is given by the following formula;

$$\text{coverage}_t = \text{risk area normal}_t * (\text{producer's cumulative yield}_{t-1} / \text{risk area cumulative yield}_{t-1})$$

Under absolute difference coverage adjustments, uncushioned coverage is given by

$$\text{coverage}_t = \text{risk area normal}_t + \text{producer's cumulative average yield}_{t-1} - \text{risk area cumulative average yield}_{t-1}$$

The analytical approach is largely the same as that applied in Phase I. Individual coverage data from producers with 8, 9, or 10 years experience in crop insurance with red spring wheat, barley, or canola was used, providing records from the same 7085 producers in Phase I. As in the analysis of the single provincial risk area, producers were initially underwritten based on the current startup coverage system which uses surrounding townships to establish the benchmark coverage, with provincial yield normals calculated as the exponential moving average of provincial yield averages since 1974. The yield normals were adjusted for the geographic drift of crops as they were in Phase I. Coverage was simulated for each individual and each crop over a 10 year period, with individual coverage adjustments made based on the difference between the producer's cumulative yield average and the cumulative provincial average yield. The results were calculated at the producer level over the 10 year time period (weighted by acreage in each year), and then averaged across producers based on mean acreage.

Comparisons were made between the single provincial risk area with absolute adjustments vs the single provincial risk area with ratio adjustments, and between the single provincial risk area with absolute adjustments and the current system. The first comparison reveals the structural nature of the differences between absolute and ratio adjustments; the second shows the empirical significance of the absolute

adjustments and single provincial risk area relative to the current system. The key criteria for evaluation in the comparisons is the mean level of coverage, the variability in coverage, and the cost of the program.

Results

The results of the comparison between absolute and ratio adjustments for the single provincial risk area for red spring wheat, barley, and canola are presented in Tables 4.1, 4.2, and 4.3 below. Based on the mean, variation, and cost of coverage, there is little difference between the absolute difference and the ratio approach to coverage adjustment. For red spring wheat in particular, there was very little difference in the adjustment approaches applying any of the criteria. The mean coverage levels and standard deviation in coverage for wheat were the same under the two approaches. For barley, the absolute deviation gives marginally lower variability in coverage. The variability in coverage is reduced to the greatest extent by the absolute adjustments in canola. For canola, the variation in coverage was reduced by approximately 5% with the absolute adjustments, with a slight decrease in cost.

Tables 4.4, 4.5, and 4.6 present the results of the comparison between the single provincial risk area and the current system. Appendix Tables 4.1, 4.2, and 4.3 present these comparisons by risk area. Because the absolute adjustments on the provincial risk area did not give substantially different results than the ratio adjustments, the results in Tables 4.4, 4.5, and 4.6 are similar to those obtained in the Phase I analysis. Relative to the current program, the provincial risk area with absolute adjustments gives slightly higher coverage, but significantly greater variability in coverage and program cost.

Conclusions

The results show that over the 10 year period of the analysis, a coverage adjustment system based on absolute differences between individual producers cumulative yield averages and the risk area average were not significantly different than the current method of indexing. This conclusion does not offer easy interpretation with respect to the essential difference between absolute vs. quantity adjustments. The reason is that with the ratio adjustments, the impact of yields from a given year is proportional to the ratio of the previous year's risk area normal to the cumulative risk area average. With absolute difference adjustments, the impact of a single year's yields is proportional to the number of years over which the average is calculated. Thus, the impact of a given year's yield on coverage under the two systems is ambiguous. Cushioning further complicates the understanding of the essential differences between absolute and ratio adjustments. Because the results from the provincial risk area with absolute adjustment are not substantially different from the initial analysis of the single provincial risk area, the conclusion that coverage is more stable and less expensive under the current system from Phase I is also obtained here.

Table 4.1 Red Spring Wheat Results, Absolute vs. Ratio Adjustment

	Single Provincial Risk Area with Absolute Adjustment	Single Provincial Risk Area with Ratio Adjustment	% Change Relative to Ratio Adjustment
Mean 70% Coverage (kg/acre)	600	600	-
Std Deviation in 70% Coverage (kg/acre)	60	60	-
Coefficient of Variation in 70% Coverage	0.1	0.1	-
Mean % Year to Year Variation in Coverage	6.2	6.1	+ 1.6
Mean % Change in Yield Normal	0.9	0.9	-
Mean Claim Rate	2.3	2.3	-

Table 4.2 Barley Results, Absolute vs. Ratio Adjustment

	Single Provincial Risk Area with Absolute Adjustment	Single Provincial Risk Area with Ratio Adjustment	% Change Relative to Ratio Adjustment
Mean 70% Coverage (kg/acre)	872	875	-0.3
Std Deviation in 70% Coverage (kg/acre)	76	78	-2.6
Coefficient of Variation in 70% Coverage	0.087	0.089	-2.2
Mean % Year to Year Variation in Coverage	4.9	5.1	-3.9

Mean % Change in Yield Normal	0.9	0.9	-
Mean Claim Rate	2.7	2.7	-

Table 4.3 Canola Results, Absolute vs. Ratio Adjustment

	Single Provincial Risk Area with Absolute Adjustment	Single Provincial Risk Area with Ratio Adjustment	% Change Relative to Ratio Adjustment
Mean 70% Coverage (kg/acre)	367	368	-0.3
Std Deviation in 70% Coverage (kg/acre)	39	41	-4.9
Coefficient of Variation in 70% Coverage	0.106	0.111	-4.5
Mean % Year to Year Variation in Coverage	5.6	5.7	-1.8
Mean % Change in Yield Normal	0.9	0.9	-
Mean Claim Rate	3.5	3.5	-

Table 4.4 Red Spring Wheat Results, Absolute Adjustment vs. Current System

	Single Provincial Risk Area with Absolute Adjustment	Current System	% Change Relative to Ratio Adjustment
Mean 70% Coverage (kg/acre)	600	584	+ 2.7
Std Deviation in 70% Coverage (kg/acre)	60	51	17.6

Coefficient of Variation in 70% Coverage	0.1	0.087	+ 14.9
Mean % Year to Year Variation in Coverage	6.2	5.3	+ 17.0
Mean % Change in Yield Normal	0.9	1.1	-18.2
Mean Claim Rate	2.3	2.1	5.52

Table 4.5 Barley Results, Absolute Adjustment vs. Current System

	Single Provincial Risk Area with Absolute Adjustment	Current System	% Change Relative to Ratio Adjustment
Mean 70% Coverage (kg/acre)	872	840	+ 3.8
Std Deviation in 70% Coverage (kg/acre)	76	68	11.8
Coefficient of Variation in 70% Coverage	0.087	0.081	7.4
Mean % Year to Year Variation in Coverage	4.9	4.7	+ 4.3
Mean % Change in Yield Normal	0.9	1.2	-25
Mean Claim Rate	2.7	2.4	12.5

Table 4.6 Canola Results, Absolute Adjustment vs. Current System

	Single Provincial Risk Area with Absolute Adjustment	Current System	% Change Relative to Ratio Adjustment
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Mean 70% Coverage (kg/acre)	367	349	5.2
Std Deviation in 70% Coverage (kg/acre)	39	37	5.4
Coefficient of Variation in 70% Coverage	0.106	0.11	-3.6
Mean % Year to Year Variation in Coverage	5.6	5.3	5.7
Mean % Change in Yield Normal	0.9	1.3	-30.8
Mean Claim Rate	3.5	3.1	12.9

V Summary

Based on the findings of this study, it appears that the 9-township virtual risk area system offers the best potential to improve the crop insurance system. It meets the stated evaluation criteria better than any of the other systems, and provides a gradient in coverage that avoids the boundary issues associated with physical risk area boundaries. The alternatives using a single provincial risk area appear to be of limited use in improving the system. The caveat to observe is that credibility concerns force the data set used in the 9-township virtual risk area to be significantly smaller than the other empirical analyses. This is particularly of concern in the Peace River and northern regions of the province, where little data satisfying the eligibility criteria was available. There is also the concern that virtual risk areas could be difficult to understand for many; it is a significant departure from previous systems.

The claim rate analysis suggests that regions with similar risk characteristics should be grouped together, and that the current risk area system does not group similar risks in all cases. An option for reform of the crop insurance system is to reconfigure risk area boundaries to better reflect like risks, or to redesign risk areas using the claim rate as a guide. An empirical analysis of specific proposals using the claim rate is required before conclusions can be drawn.

Appendix 1.1 Comparison of Provincial and Current Risk Areas, Red Spring Wheat

Prov	Mean 70% Coverage (kg/sec)			Std Dev In 70% Coverage (kg/sec)			Coefficient of Variation			Claim Rate (%)			Records
	Prov	RA	% Change	Prov	RA	% Change	Prov	RA	% Change	Prov	RA	% Change	
1	600.00	584.00	2.74	60.00	51.00	17.65	0.10	0.087	14.51	2.3	2.1	9.5	35636
2	470.00	451.00	4.21	63.00	61.00	3.28	0.134	0.135	-0.90	8.8	7.8	12.8	27
3	570.00	537.00	6.15	58.00	48.00	20.83	0.102	0.089	13.84	1.7	1.6	6.25	2967
4	577.00	523.00	10.33	79.00	65.00	21.54	0.137	0.124	10.16	1.4	1	40	3454
5	475.00	428.00	11.50	101.00	78.00	29.49	0.213	0.183	16.13	3.1	2	55	3304
6	655.00	659.00	-0.61	54.00	50.00	8.00	0.082	0.076	8.66	1.5	1.6	-6.25	3601
7	753.00	744.00	1.21	26.00	31.00	-16.13	0.035	0.042	-17.13	0	0.00	0	8
8	875.00	898.00	-2.56	59.00	51.00	15.69	0.067	0.057	18.73	1.3	1.3	0	726
9	470.00	448.00	4.91	45.00	45.00	0.00	0.0844	0.064	0.14	0.7	0.7	0	3923
10	809.00	809.00	0.00	62.00	49.00	26.53	0.132	0.109	20.61	4.1	3.4	20.6	4630
11	889.00	906.00	-1.88	55.00	66.00	-10.61	0.073	0.082	-10.61	1.6	1.6	0	123
12	663.00	654.00	1.38	44.00	40.00	10.00	0.066	0.061	8.51	1.8	1.8	0	807
13	624.00	625.00	-0.16	50.00	47.00	6.38	0.08	0.075	6.55	1.7	1.6	6.25	4875
14	614.00	630.00	-2.54	50.00	29.00	72.41	0.081	0.046	76.91	2.7	3.6	2.8	3863
15	789.00	803.00	-1.74	84.00	85.00	-1.18	0.164	0.1058	0.58	2.5	2.5	0	17
16	0	0	0	0	0	0	0	0	0	2.7	2.9	-6.9	398
17	555.00	568.00	-2.29	62.00	62.00	0.00	0.112	0.109	2.34	0	0	0	0
18	611.00	611.00	0.00	64.00	62.00	3.23	0.105	0.101	3.23	8.7	9	-3.33	95
19	676.00	683.00	-1.02	54.00	52.00	3.85	0.08	0.076	4.92	5.7	5.6	1.8	247
20	655.00	636.00	2.99	56.00	47.00	19.15	0.085	0.074	15.89	3.3	3.3	0	1653
21	535.00	533.00	0.38	31.00	21.00	47.62	0.058	0.039	47.07	5.6	5.2	7.7	201
22	594.00	595.00	-0.17	45.00	48.00	-6.25	0.076	0.081	-6.09	7.3	7.3	0	390
										3	2.9	3.4	327